TENNESSEE DEPARTMENT OF EDUCATION
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Mechatronics II

Primary Career Cluster:	Advanced Manufacturing
Consultant:	Casey Haugner Wrenn, (615) 532-4879, Casey.Haugner@tn.gov
Course Code(s):	6157
Prerequisite(s):	*Mechatronics I* (6156) and *Physics* (3231) Note*: Physics* (3231) may be taken as a co-requisite.
Credit:	1
Grade Level:	12
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Manufacturing courses.
Programs of Study and Sequence:	This is the fourth and final course in the *Mechatronics* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.tnskillsusa.com Brandon Hudson, (615) 532-2804, Brandon.Hudson@tn.gov Technology Student Association (TSA): http://www.tntsa.org Amanda Hodges, (615) 532-6270, Amanda.Hodges@tn.gov
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit http://tn.gov/education/cte/work_based_learning.shtml.
Available Student Industry Certifications:	If a student successfully completes both *Mechatronics I* and *II*, he or she is eligible to sit for Level 1 Siemens Certified Mechatronic Systems Assistant certification.
Dual Credit or Dual Enrollment Opportunities:	There are currently dual enrollment opportunities with specific community colleges, including Motlow State Community College.
Teacher Endorsement(s):	157, 232, 233, 470, 477, 523, 537, 551, 552, 582, 596, 701, 760
Required Teacher Certifications/Training:	None
Teacher Resources:	http://www.tn.gov/education/cte/Manufacturing.shtml

Course Description

Mechatronics II is an advanced course in the manufacturing career cluster for students interested in learning more about such careers as mechatronics technician, maintenance technician, or electromechanical technician. Following the groundwork of mechanics and electronics laid in

Mechatronics I, this course covers basics of pneumatic, electro pneumatic, and hydraulic control circuits in a complex mechatronic system. In addition, the course addresses basic digital logic and programmable logic controllers (PLCs) employed in the mechanical, electronic, and control systems in a mechatronics system. Upon completion of this course, proficient students are able to explain the inter-relationships of components and modules within a complex mechatronic system. They understand the differences between hydraulic and pneumatic fluid power and can explain the scientific principles that apply. They also use technical documentation (such as datasheets, circuit diagrams, displacement step diagrams, timing diagrams, and function charts) to troubleshoot and resolve malfunctioning pneumatic and hydraulic components and circuits. They demonstrate understanding of the role of programmable logic controllers (PLC) in mechatronic systems and the ability to write, debug, and run basic ladder logic. Standards in this course are aligned with Tennessee State Standards for English Language Arts & Literacy in Technical Subjects and Tennessee State Standards in Mathematics.*

Program of Study Application

This is the fourth course in the *Mechatronics* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Manufacturing website at http://www.tn.gov/education/cte/Manufacturing.shtml.

Course Standards

Safety

1) Accurately read and interpret safety rules, including but not limited to the rules of handling high-pressure pneumatics and hydraulics. Analyze the implications of the various rules and employ them accordingly while working on mechatronic systems with control system components, explaining why certain rules apply. (TN Reading 1, 3)

Fluid Power Systems

2) Demonstrate understanding of the interrelationships and specific roles of (electro) pneumatic and hydraulic components and modules within a complex mechatronic system. For example, provide a written technical description of the expected changes in one or more systems on other components and modules in the total mechatronic system. (TN Reading 9; TN Writing 2)

3) Identify the differences between hydraulic and pneumatic fluid power and justify decisions surrounding when to use control systems based on one component as opposed to the other by crafting and defending an argument with specific claim(s), reasoning and supporting evidence. (TN Reading 9; TN Writing 1)

4) Create laboratory setups or simple control systems that apply hydraulic and pneumatic principles such as Boyle's Law and Pascal's Law. Apply these principles to solving problems and troubleshooting mechatronic systems, explaining the reasoning behind each step. (TN Reading 5; TN Math A-REI)

5) Using real-world examples of hydraulic/pneumatic systems, and citing reputable print and visual sources of such systems, conduct research to identify the basic components and functions in a

fluid power system. Create a visual aid to summarize and explain this information to technicians or upper management. (TN Reading 7; TN Writing 6)

6) Measure and analyze basic physical properties of (electro) pneumatic and hydraulic components (such as cylinders, directional control valves, regulators, flow control valves, pumps, and motors) within a given system. Interpret resolved work orders by analyzing underlying issues and explaining the correct physical operation of the included components. (TN Reading 6, 8; TN Writing 2)

7) Citing evidence from a technical description or actual observation of a mechatronic system, describe the flow of fluid energy in a given mechatronic system or subsystem. Create a graphic illustration to represent the transfer of energy from one component to others in the system. (TN Reading 1; TN Writing 4)

Computers and Control Systems

8) Research the different roles of programmable logical controllers (PLCs) in complex mechatronic systems, modules, and subsystems, and be able to verbally describe their components and operation to others. Collaboratively create a technical document for a new technician that explains the basic components of a PLC, addressing how the role of a PLC varies in different systems (such as mechatronic systems, modules, and subsystems). (TN Reading 6, 9; TN Writing 2, 6)

9) Demonstrate understanding of the flow of information in a given mechatronic system or subsystem, focusing on the control function of PLCs in the system. Create both a schematic and explanatory narrative to describe the flow of information to/from an equipment operator. (TN Reading 4, 7; TN Writing 2, 4)

10) Given a control scenario, bound by several logical parameters, create Boolean logic equations to prescribe the use of logic gates in the implementation of the scenario. Show how they apply to the functioning of a real-world mechatronics system, explaining the reasoning involved. (TN Reading 4; TN Writing 4; TN Math A-CED; A-REI)

11) Demonstrate understanding of hexadecimal, decimal, octal, binary, 2s complement, and binary coded decimal (BCD) values as used in a common PLC. Write an explanation or develop and deliver a brief presentation of how these codes are relevant to mechatronic systems. (TN Reading 4, 7; TN Writing 2)

12) Convert wiring and ladder diagrams for simple logic chores into PLC programs that use common instructions such as digital, logical, compare, compute, move, file, sequencer, and program control instruction sets. (TN Reading 3; TN Writing 4, 9; TN Math A-REI)

Technical Documentation and Troubleshooting

13) Referencing technical documents (such as data sheets, circuit diagrams, displacement step diagrams, timing diagrams, function charts, operations manuals, and schematics) for pneumatic and hydraulic components within a mechatronic system, assess the required maintenance for

such systems, taking appropriate measurements where needed, and perform the necessary adjustments on these systems. Document and justify adjustments in an equipment log that can be referenced by technicians and engineers. (TN Reading 3, TN Writing 2, 8)

14) Troubleshoot malfunctioning pneumatic and hydraulic systems: identify the source of the problem(s), plan a multistep procedure to correct the malfunction, implement the plan, and verify the corrective action. Using appropriate technical language and terminology, document the cause of the malfunction and justify the procedure used to correct it. (TN Reading 3, 4, 9; TN Writing 1, 9)

Standards Alignment Notes

*References to other standards include:

- TN Reading: Tennessee State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
    - Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standards 2 and 10 at the conclusion of the course.
- TN Writing: Tennessee State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3, 5, 7, and 10 at the conclusion of the course.
- TN Math: Tennessee State Standards for Mathematics; Math Standards for High School: Algebra.
    - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project based activities or collaborate on lesson planning. Students who are engaging in activities listed above should be able to demonstrate algebraic reasoning as applied to specific technical concepts. In addition students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning.
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.